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Subject: *IBM Confidential: Disclosure: Method To Achieve Low and Stable Ferromagnetic Coupling Field

METHOD TO ACHIEVE LOW AND STABLE FERROMAGNETIC COUPLING FIELD

Achieving low ferromagnetic coupling field and controlling it upon annealing cycles is one of the key challenges for top spin valves. A new method has been presented where ferromagnetic coupling of the free layer can be lowered and dR/R be enhanced for a given copper spacer thickness. Use of oxygen in a deposition chamber at ~5x10-9 torr pressure range during deposition or exposing the top Cu surface to oxygen has been reported to improve the GMR for bottom spin valves (Egelhoff et.al. JAP, 82(12),1997). However maintaining this kind of pressure in a large manufacturing type system may be difficult due to very small pressure window and our experiments have shown that exposing the top Cu surface to oxygen does not improve the Hf of top spin valves. We have developed a new method for top SV's where a burst of oxygen is introduced into the vacuum chamber both before and after Cu spacer deposition for about 30 seconds. The oxygen partial pressure in the vacuum chamber reaches 5x10-6 Torr during the oxygen burst and then rapidly decreases below 10-8 Torr levels before the actual layer deposition starts. No additional steps or any extra time are added to incorporate the oxygen bursts into the standard SV deposition process. It is determined in this work that the best results are obtained when the oxygen molecules are directed toward the substrate and the substrate shutter is fully open for substrate to be directly exposed to the oxygen beam. Oxygen is physisorbed on surfaces including the freshly deposited SV layer surfaces (usually CoFe and Cu). This surface adsorption limits the intermixing between the layers and provides a smooth surface to obtain a lower ferromagnetic coupling field.

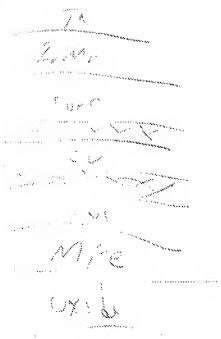
Another significant result from this method is that the ferromagnetic coupling field is extremely stable upon hard bake annealing cycles at 232C for 11 hours or at 270C for 6 hours. This type enhancement upon annealing has not been reported for the previous methods for bottom spin valves.

The results below show the O2 exposure affect on the Hf of the spin valve structures which are identical except the O2 exposure step. The spin valve structure is listed below. The oxide seeds are NiO,NiMnO, etc.

Oxide seed	= 40A
NiFe	= 50A
CoFe	= 10A(NiFe eq.)
Cu	= 23A
CoFe	= 24A
IrMn	= 80A
Ta	= 50 A

The properties of the spin valves is listed below. The type A SV has oxygen exposure of Cu spacer surface only. Type B spin valve has oxygen exposure of CoFe surface before the Cu layer and the oxygen exposure of the Cu surface as well. The data shows that the coupling field is 2.5X times smaller with the new method compared to the oxygen exposure of Cu surface only. This low coupling field for spin valve Type B does not degrade upon 232C hard bake anneal. Indeed samples annealed (#148) at 232 and 270C for 11 and 6 hours respectively kept the same ferromagnetic coupling field at around 8 Oe.

		Type A	TypeB
dR/R(%)	=	6.35	8.12
R(Ohm/sq.)	=	20	20
Hs(Oe.)	=	16	6.5
Hc(Oe.)	=	4	5



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O_2 adsorption on surface to reduce roughness &